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PARTHENOGENESIS AND SEXUAL REPRODUCTION IN
ROTIFERS. EXPERIMENTAL RESEARCH UPON
BRACHIONUS PALA¹

IN a recent number of *Bios* Miss Lina Moro has presented some interesting and suggestive results from experiments upon the rotifer, *Brachionus pala*. She has subjected the parthenogenetic females to various chemicals, to changes in nutrition, and to changes in temperature.

In using FeCl_3 solutions she has been able to produce male-producing females in small numbers while in control experiments in which no FeCl_3 was used no male-producing females were produced. Many dilutions of FeCl_3 were used but $M/12,000$ seemed to be the optimum dilution. This was added to the culture water of hay infusion in which the rotifers were living. Although the number of the experiments were rather small and the percentage of male-producing females obtained was not higher than 12 per cent., nevertheless they indicate the possibility of a specific chemical being able to induce the production of male-producing females.

Not only did FeCl_3 cause male-producing females to appear but it also caused the mothers to form the eggs much faster in their bodies and to extrude them to the outside much faster than those in the controls. Usually while a female in the control was producing one egg a female in the FeCl_3 would produce four eggs. This rapid formation and production of eggs after it was once started continued through many subsequent generations during the three months in which the experiments were carried on. It might be considered that this new characteristic induced by a chemical was a case of the formation of a new character which, after it was once formed, was inherited by the descendants.

It was also determined that the influence of the FeCl_3 acted upon the egg while it was yet inside the mother and caused it to develop into a male-producing female. After the egg was laid its development could not be altered from a female-producing female to a male-producing female by the use of FeCl_3 .

A dilution of HgCl_2 ($M/1,200,000,000$) was also effective in causing male-producing females to appear but a smaller number of offspring were produced than in the FeCl_3 . The percentage

¹ "Partenogenesi e Anfigonia nei Rotiferi. Recerche sperimentali sul *Brachionus pala*," by Lina Moro, *Bios*, Vol. 2, Fasc. 3, pp. 219-264, 1915.

of male-producing females produced was about 18 per cent. It also caused an increase in the number and the rate of production of the eggs by each female as was the case in the FeCl_3 experiments. KCl ($M/12,000$) in the very few experiments recorded caused about 16 per cent. of male-producing females to appear and CaCl_2 ($M/12,000$) caused about 33 per cent. of male-producing females to appear. In the controls for these experiments no male-producing females appeared. In all of these chemical experiments each mother after being transferred from the control to the culture media containing the various chemicals produced a family of several daughters but in each family there was never more than *one* male-producing daughter. In the FeCl_3 solutions each mother produced many daughters and as only one of them in each family was a male-producer the percentage of male-producing females was necessarily lower whereas in the HgCl_2 , KCl , CaCl_2 , solutions each mother produced fewer daughters than in the FeCl_3 solutions, and as only one of these in each family was a male-producer, the percentage of male-producing females was consequently higher. Various dilutions were used of AlCl_3 , KCN , NaCl , Na_2HAsO_4 , HCl , and NaOH but none of them caused male-producing females to appear.

In the nutrition experiments it was found that a constant diet at a uniform temperature of 15°C .– 17°C . or 25°C .– 27°C . produced only female-producing females but in some experiments in which an abundance of food was used for a time and then was followed by a period of scanty food or semi-starvation many male-producing females appeared, especially at the lower temperature.

In some of the experiments a temperature of 15°C .– 17°C . produced all female-producing females but when the mothers were put at a temperature of 25°C .– 27°C . or at 31°C . as high as 50 per cent. of the daughters were male-producers. When these same mothers were transferred back to 15°C .– 17°C . they again produced only female-producing daughters. In a few experiments at a constant temperature of 25°C .– 27°C . only female-producing females were produced but when the mothers were put at a lower temperature they produced many male-producing daughters. The general conclusion drawn is that whenever the general cultural conditions are constant and uniform, whether they refer to nutrition or to temperature, only female-producing females are produced but when the cultural conditions are sud-

denly changed by the disappearance of an abundant diet or by the rise or fall in the temperature male-producing females are produced at once. In a few experiments very young females (1-7 hours after hatching) were put from a high temperature to a temperature of 9° C.-11° C. and many of them developed into male-producers but whether this was due to the temperature or to some other factor was not known.

Another fact of considerable interest was verified. It concerned the nature of the male-producing females and the sexual females (the females which produce fertilized eggs). It has been observed by several investigators that if the small male eggs of a male-producing female are fertilized, in a species of *Asplancha* and *Hydatina senta*, they develop into the winter or resting eggs. This was found to be true also in *Brachionus pala*.

In all the families of daughters from the various mothers it was found that the male-producing daughters were among the earliest ones produced of each family. This was observed in the families of *Hydatina senta* by an earlier worker but later it was found to be due entirely to the method of feeding.

Although, as stated previously, the observations recorded in this paper are from a rather small number of individuals and ought to be expanded and verified, nevertheless, they show that in this rotifer the production of female-producing or male-producing females can be regulated by the environment and thus the results are in a general accord with the observations obtained by several workers with the rotifers, *Asplancha*, and *Hydatina senta*.

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